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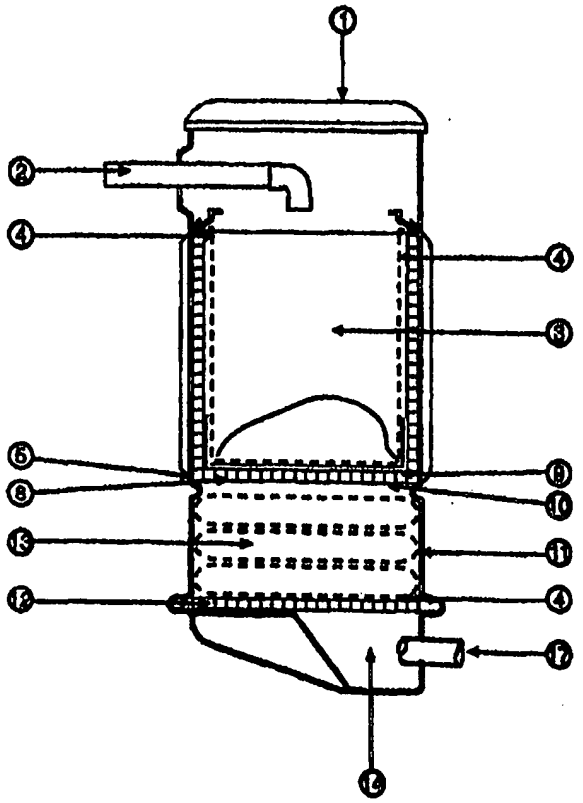
(57) Abstract

A waste water treatment apparatus (1) for effluent containing biodegradable solids having a first chamber (3) for retaining the solids while allowing liquid effluents to pass therethrough to a filtering chamber (11) which contains a filter medium (13, 32). The solids (biomass) are digested by worms and/or bacteria in the first chamber (3) and the liquid effluents from the first chamber (3) are treated by bacteria which is in the filter medium (13, 32). The thus purified water passes into the holding chamber (14) from where it is used for gardening or as required.



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Waste Water Treatment System

The present invention refers to a waste water treatment system, and in particularly a waste water treatment system for on site treatment of liquid wastes, such as sewerage and slurries:- known as a point source solution..

In the present treatment of liquid wastes and sewerage, the liquid waste is transported by underground impervious piping or open channel, to a central treatment system or in extreme cases simply discharged into waterways or in the case of mine effluent, the effluent is usually discharged into tile dams or open basins without treatment. A centralised treatment system requires the use of pumps, clarification equipment, and chemicals. The cost of maintaining and installing such systems is extremely high, as it requires an extensive network of impervious piping or open channels which usually occupies a large area of valuable land. Further problems arise during heavy rain, because excess storm water run off in some areas are directed into the sewerage system, which results in raw sewage discharge from the sewerage systems into the streets and the river systems or held in tile dams or open basins. Other problems occur with broken pipes leaking untreated effluent into the local environment and eventually into the water table, aquifers and river systems.

Such leakage of untreated effluent can cause problems such as polluted aquifers, river ways, soil contamination, algae blooms, unpleasant toxic smells, air pollution, and illnesses, as well as reduction in the fauna and flora..

Further in isolated communities, such as mining settlements, and in other areas where sewerage is not connected, individual on site sewerage collection systems such as septic tanks, biological toilets and incinerator toilets have been used, with varying degrees of success. However, increasingly, laws are being enacted to prevent inefficient and unsafe system, including burning of waste, because of the resultant air and water pollution, and to phase out septic systems.

Problems, also, occur with the treatment of other waste water, both domestic and industrial. In some systems bathroom and kitchen sink water are fed directly into the sewerage system, thus greatly increasing the volume of effluent, containing contaminated biomass in various degrees of decomposition, travelling through the sewerage system. In other systems, these waste waters are fed into anaerobic grease traps where the overflow percolates into the soil and into the water table, or as run off and into the water ways. Some of this liquid waste is high in phosphorus and nitrogenous compounds, which cause

algae blooms and high COD (chemical oxygen demand) and BOD (biological oxygen demand), hence deoxygenate the river systems.

The present invention seeks to ameliorate the above problems by providing an on site liquid effluent treatment apparatus for effluent, containing biodegradable solids, comprising:

a first chamber adapted to receive untreated effluent, said chamber having at least a permeable portion to allow liquids to pass therethrough and to retain the biodegradable solids in the first chamber, thereby substantially dewatering the solids, and containing bacteria and/or worms to digest the biodegradable solids;

a second chamber in cascade with the first chamber and separated therefrom with an air gap, said second chamber containing a suitable filter medium, such that liquid which passes through the first chamber percolates through the filter medium ;

a third chamber located below the second chamber to receive the treated liquid from the second chamber; and

an outlet from said third chamber to allow removal of the treated liquid from the third chamber.

The liquid in the third chamber can be oxygenated with air or oxygen, or ozone, depending upon their toxicity levels.

In another form, the present invention provides an on site waste water purification apparatus for purifying water containing liquid or dissolved contaminants, comprising:

a first holding chamber adapted to receive the waste water mixture, said chamber having a permeable base to allow liquids to pass therethrough;

a first filter chamber, in cascade with the first holding chamber, and containing a suitable filter medium, such that liquids which passes through the first holding chamber percolates through the filter medium ;

at least a second holding chamber, located below the first filter chamber to receive the filtered liquid from the first filter chamber, and having a permeable base; and

at least a second filter chamber in cascade with the at least second holding chamber, and containing a suitable filter medium, such that liquid which passes through the at least second holding chamber percolates through the filter medium,

whereby the liquid or dissolved contaminants are separated from the water as the water, firstly, percolates through the various filter medium, with the

liquid or dissolved contaminants remaining in the filter medium, where it is digested by bacteria.

The present invention will now be described with reference to the accompanying drawings in which:

Figure 1 illustrates an on site liquid effluent treatment apparatus according to one embodiment of the present invention;

Figure 2 illustrates an on site liquid effluent treatment apparatus according to another embodiment of the present invention;

Figure 3 illustrates the liquid effluent treatment apparatus shown in figure 2, in a system for treating domestic washing water;

Figure 4 illustrates the liquid effluent treatment apparatus shown in figures 1 or 2, in a system for treating sewerage;

Figure 5 illustrates an on site liquid effluent treatment apparatus according to a further embodiment of the present invention;

Figure 6 illustrates an on site liquid effluent treatment apparatus according to a further embodiment of the present invention;

Figure 7 illustrates an on site liquid effluent treatment apparatus according to a further embodiment of the present invention;

Figure 8 illustrates an oil water separator according to an embodiment of the present invention;

Figure 9 illustrates a view of a piece of drainage cell as shown in Australian patent no. 593085 which is suitable for use in the present invention; and

Figure 10 shows actual test results of a trail of the filtration system of the present invention.

In a full flush of a toilet, normally a minimum of six litres of flushing water is used. Thus during a day a large volume of water is as well as the faecal solids, which contain approximately 82-92% water, are flushed into the sewer system. As the population of areas grow the load on the sewerage system increases, and in some cases the system cannot cope.

However the present invention, rather than have a centralised treatment centre, provides an on site treatment apparatus which could be used for a single toilet or a series of toilets, as well as bathroom and kitchen liquid waste, thereby eliminating the need for a large network of piping throughout the city and suburbs, and the subsequent maintenance cost and risks of major overflows. Further the retention of the treated water, which could be used for gardens , washing or other non potable uses, would lower the water usage from the reservoirs.

The invention will now be described with reference to treatment of domestic liquid effluent. As shown in figure 1, the liquid waste treatment apparatus (1) comprises an inlet pipe (2) to convey waste from the toilet system (see figure 4) or the kitchen sink or bathroom (see figure 3) of a house into a waste receiving chamber (3). The chamber (3) contains a geofabric or micro filter bag (4), shaped so as to line the walls of the chamber (3).

The base (5) of the waste receiving chamber (3) is perforated and could be constructed, as shown in figure 9, of modules of *ATLANTIS*® DRAINAGE CELLS, which are shown in Australian patent no. 593085. These modules have two parallel perforated surfaces (9 &10), joined by columnar members (27),

forming an air gap (8) therebetween. On the under side of the support surfaces (28) are upturned walls (29) which form wells (30) in which effluent is retained.

Therefore when the toilet is flushed the liquid waste and the faecal solids are collected in the waste receiving chamber (3) as shown in figure 1, where the urine and liquid wastes drain through the bottom (5) of the waste receiving chamber (3) . Suitable bacteria is placed in the waste receiving chamber (3), together with manure worms. The worms and the bacteria digest the faecal solids, which remain in the waste receiving chamber (3), in a very fast time, and leave, as residue, worm castings. The worms are capable of eating their own weight a day.

A filter chamber (11) lies directly below the receiving chamber (3), to receive the filtered liquid waste from the waste receiving chamber (3). A microfilter medium (4) such as a geofabric lies below the bottom surface (10) of the base (5) of the receiving chamber (3), and a further microfilter medium (4) such as a geofabric lies above the top surface of the perforated base (12) of the filter chamber (11), which could be constructed, as shown in figure 1, of modules of *ATLANTIS*® DRAINAGE CELLS. Between the micro filter layers (4), the chamber can be filled with a granulated filter medium (13). This medium could be any suitable material such as sand or a mixture of sand and zeolite,

together with a decontamination agent and of any suitable grain size. In the embodiment shown the material is a granulate mixture of zeolite, with Borax as the decontamination agent. Suitable bacteria is also preferably used in the filter medium, to assist in the removal of contaminants.

However as shown in figure 1, the granulated filter medium (13) could be contained in several bags (6) of microfilter medium (4), which are secured across the filter chamber (11) to ensure that all liquid must pass through the filter medium (13). Each bag could have a different strain of bacteria.

The liquid waste, that passes from the receiving chamber (3), falls through the air gap (8), onto the filter medium (13), and spreads along the filter medium bed and percolates through the interstices between the grains of the filter medium (13), where the pollutants are digested by the bacteria in the filter medium (13).

In the process of liquid passing through a granular layer, liquid will be retained in the granular layer in an increasing amount from the top of the layer to the bottom, with very little or no liquid being present at the top to being almost fully saturated with water at or adjacent the bottom of the layer. However there are still air pockets in the interstices between the grains, in the lower level

of the layers This retained water is known as "perch water". Further as liquid percolates down through the layers, air flows upwardly. Therefore, as the pollutants percolate through the granular layer, they pass from an aerobic region through an increasingly anaerobic region. The thickness and top surface area of the filter medium (13) is such that the retention time of the liquid in the filter medium (13) is sufficient to remove the impurities to a predetermined degree, such that the treated water is useable, for example, for watering the garden.

The treated water then drips into a holding chamber (14) where it is aerated as it falls into the chamber (14), and exits through the outlet (17). To assist in the treatment process air or oxygen could be pumped into the treated water in the holding chamber (14), to increase the aeration of the treated water and also to increase the flow of oxygen through the filter medium (13). Also air or oxygen could be fed into the lower levels of the filter medium (13). Additionally a small mercury lamp could be used to convert some of the oxygen into ozone, in the air that is pumped into the treatment system.

A further embodiment is shown in figure 2, which is of similar construction to the embodiment shown in figure 1 except that the base (5) and the lower walls of the waste receiving chamber (3) have an impervious insert

(7) to form a well (15) to retain a depth of the liquid as well as the faecal solids in the waste receiving chamber (3), while the remainder of the liquid effluent flows over the impervious insert (7) and passes through to the filter chamber (11). Suitable bacteria and a quantity of water is placed in the well (15), where the bacteria digest the faecal solids in a very fast time.

The present invention provides separation of the faecal solids from the liquid wastes, so that each can be treated separately. The solids being separated, and digested by worms and/or specific bacteria, and the liquid wastes: flushing water, urine, faecal liquids, and liquids liberated by the digestion of the faecal solids, percolating through a reactive filter material where the bacteria breaks down the organic material into water and carbon dioxide, and breaks down ammonia and ammonium ions into nitrogen and water while producing oxygen, and retains metal ions and phosphorus, within the filter medium (13).

The results of a trial on a stormwater drainage system, using of a waste water treatment system according to an embodiment of the present invention is shown in figure 10. As can be readily seen the pollutants have been greatly removed.

In an embodiment of the present invention, not shown, there are three waste receiving chambers; each chamber with an air gap surrounding it, with a barrier between each chamber to prevent flow between the chambers. Hence when the first chamber becomes full of worm casings or bacteria and over flows into an adjacent chamber, the feed of sewerage waste is then transferred to one of the other chambers and the process continued. The full chamber is then left to mature; ie all faecal waste has been converted into worm casings or digested down to a safe product, and after maturing the microfilter bag (4) and its contents is removed and a new bag inserted for future use.

The walls of the waste receiving chambers are porous and could be constructed, as could be the base, as shown in figure 1, of modules of *ATLANTIS*® DRAINAGE CELLS, so as to provide an adequate air flow around each chamber.

As shown in figure 3, the waste water treatment apparatus (1) could be connected to sink or bathroom waste water outlet and the treated and filtered water passed to underground percolation tanks (16) which supply water to the surrounding plants. The tanks (16) could be contained in an impervious well (23).

In figure 4, the outlet from the toilet is feed into the waste water treatment apparatus (1), as shown in figure 2, and the water fed to a series of tanks (16) contained in an impervious well (24). A pump (25) can be used to spray water held in the well (24) onto gardens. Further instead of using the impervious well (15) to maintain a head of water in the waste receiving chamber (3), the outlet pipe (17) could be raised vertically, thereby creating the head at the level of the outlet.

The various tanks (16) and their walls can be constructed, as shown in figure 1, of modules of *ATLANTIS*® DRAINAGE CELLS, the subject of International patent application no. PCT/AU94/00771.

A further embodiment is shown in figure 5, for use with a larger dwelling such as a block of units. In this case the treatment systems uses a large moveable container (18), which, when full, could be disconnected from the system and removed and replaced by a fresh container.

The system works similarly to the system described previously, toilet wastes and kitchen and bathroom wastes are fed in through an inlet pipe (2) into a waste holding chamber (19), which contains suitable bacteria and worms, as mentioned previously, to digest the faecal solids, while the liquid wastes flow

from the waste receiving chamber (19), through the perforated side walls (20) and base (21), through an air gap (8) to a lower first filter chamber (11). Further the chamber 19 could have a layer of filter medium (13) containing only bacteria, as described previously. As shown the walls of the waste receiving chamber (19), could be made of tank modules (16) as described in International patent application no. PCT/AU94/00771. Further the waste receiving chamber

In this embodiment several filter chambers (11 & 22) are used in cascade. Filter medium (13), as mentioned in the first embodiment is used, and each filter chamber (11 & 22) is separated by an air gap (8). Hence a "perch water" table is formed in each filter chamber (11 & 22), with the resultant gradient of aerobic to increasingly anaerobic reaction down through the filter medium of each filter chamber (11 & 22).

By using multiple layered filter chambers, separated by an air gap, different reactive material and bacteria, can be placed in each filter chamber to target specific pollutants. Again, as described above, the input of air or generated ozone can be used to increase the efficiency of the system and

The treated water percolates through the various filter chambers (11 & 22) and is collected in the lower chamber (23), where it is removed for use for

watering the gardens or, depending upon the degree of treatment, for washing or drinking.

A further embodiment is shown in figure 6, which is similar in construction to that shown in figure 5 except that a well (15) is formed in the waste receiving chamber (3) by an impervious insert (7) and air (31) is passed into the holding chamber (14).

Figure 7 illustrates a further embodiment which is similar to that shown in figure 6 except that the filter medium in the filter chamber (11) is replaced by layers of modules (32) of *ATLANTIS*® DRAINAGE CELLS, according to Australian patent no. 593085, an example of which is shown in figure 9. The drainage cells have small wells (30) to hold liquids in which bacteria collects and the layers of drainage cell modules act as a trickle tower. Further the surfaces of the plastics material of the drainage cells become coated with bacteria and the bacteria digest the effluent.

Thus the above embodiments provide the following features:

- diluting or dewatering of the faecal solids;
- anaerobic or aerobic degradation of the faecal solids by bacteria and/or worms to provide a useable by product

- filtration through the filter medium with, in the case of granulated filter medium, variable perch water through the filter medium;
- removal of pollutants from the water systems; and
- saving of valuable land due to on site treatment and disposal or usage.

A further embodiment is shown in figure 8 for the purification of water contaminated with liquid or dissolved effluent The operation of this apparatus will now be described with reference to the separation of water and oil. This embodiment works in the similar way to the previous embodiments, except there are no worms or bacteria in the initial receiving chamber (24).

A filtered oil water mixture is fed into the initial holding chamber (24) where the water (25) and oil (26) begin to separate, depending upon the amount of liquid in the chamber. The water and oil permeates through successive layers of filter chambers, filled with suitable filter medium, such as those mentioned previously, containing oil digesting bacteria, and holding chambers.

Thus after using a predetermined number of stages the water has been separated from the oil, which remains in the filter material for digestion. When

the filter medium becomes spent, either the whole container is replaced or the system dismantled and the spent filter medium replaced.

The filter chambers can be of any suitable thickness and porosity to suit the requirements. The various chambers and their walls can be constructed, as shown in figure 1, of modules of *ATLANTIS*® DRAINAGE CELLS.

The on-site units could be adapted for connection to a single toilet or a single sink outlet and then fed to appropriate holding tanks for use in gardening washing or drinking, or dispersion tanks which are surrounded by a layer of suitable sand to allow the treated water to disperse back into the soil where it is used by surrounding trees and plants.

It should be obvious to people skilled in the art that alterations and modifications could be made to the above described embodiments without departing from the scope and spirit of the present invention.

The claims defining the invention are as follows:

1. An on site liquid effluent treatment apparatus for effluent, containing biodegradable solids, comprising:

a first chamber adapted to receive untreated effluent, said chamber having at least a permeable portion to allow liquids to pass therethrough and to retain the biodegradable solids in the first chamber, thereby substantially dewatering the solids, and containing bacteria and/or worms to digest the biodegradable solids;

a second chamber in cascade with the first chamber and separated therefrom with an air gap, said second chamber containing a suitable filter medium, such that liquid which passes through the first chamber percolates through the filter medium ;

a third chamber located below the second chamber to receive the treated liquid from the second chamber; and

an outlet from said third chamber to allow removal of the treated liquid from the third chamber.

2. An on site liquid effluent treatment apparatus according to claim 1, wherein the filter medium contains bacteria to digest the effluent.

3. An on site liquid effluent treatment apparatus according to claim 1 or 2, wherein the first chamber has perforated walls and floor covered in a geofabric or micro filter material.

4. An on site liquid effluent treatment apparatus according to any one of the preceding claims, wherein the filter material is a granulated material layered between two layers of geofabric or micro filter material.

5 An on site waste water purification apparatus for purifying water containing liquid or dissolved contaminants, comprising:

a first holding chamber adapted to receive the waste water mixture, said chamber having a permeable base to allow liquids to pass therethrough;

a first filter chamber, in cascade with the first holding chamber, and containing a suitable filter medium, such that liquids which passes through the first holding chamber percolates through the filter medium ;

at least a second holding chamber, located below the first filter chamber to receive the filtered liquid from the first filter chamber, and having a permeable base; and

at least a second filter chamber in cascade with the at least second holding chamber, and containing a suitable filter medium, such that liquid which

passes through the at least second holding chamber percolates through the filter medium,

whereby the liquid or dissolved contaminants are separated from the water as the water, firstly, percolates through the various filter medium, with the liquid or dissolved contaminants remaining in the filter medium, where it is digested by bacteria.

6. An on site waste water purification apparatus according to claim 5, wherein the first chamber has perforated walls and floor covered in a geofabric or micro filter material.

7. An on site waste water purification apparatus according to any one of claims 5 or 6, wherein the filter material is a granulated material layered between two layers of geofabric or micro filter material.

Fig 1

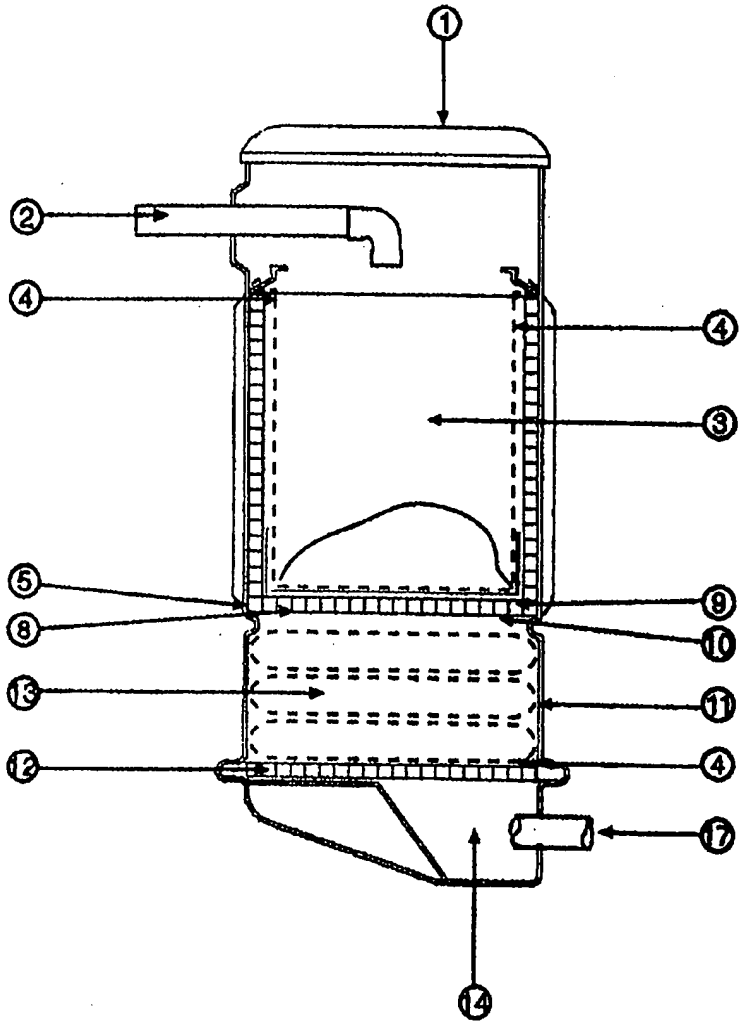
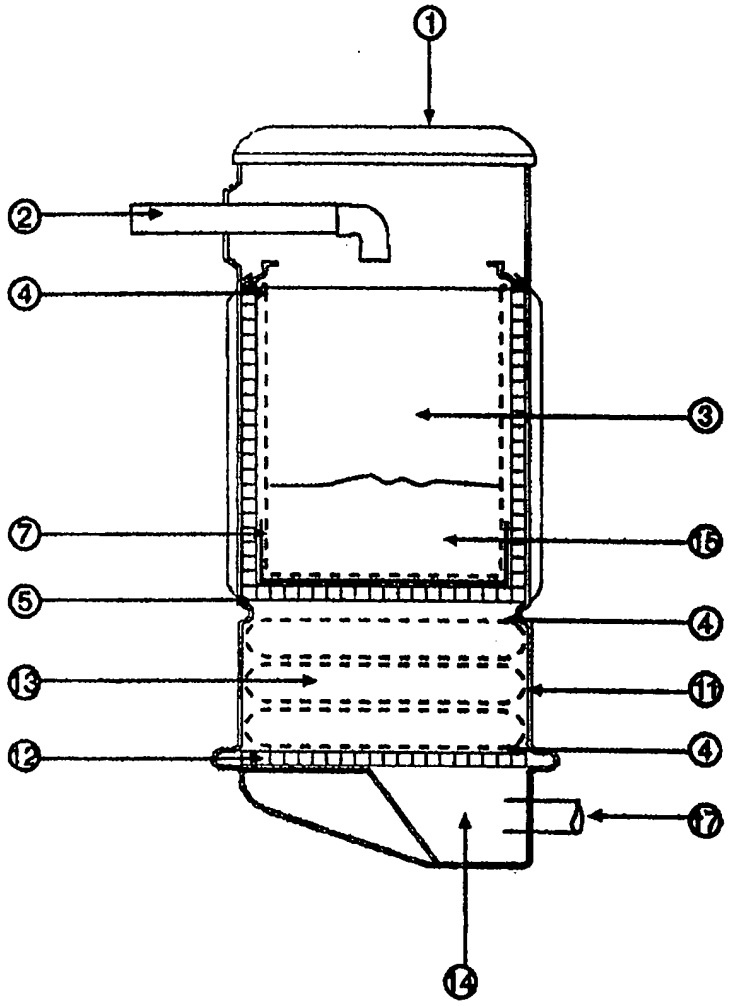


Fig 2



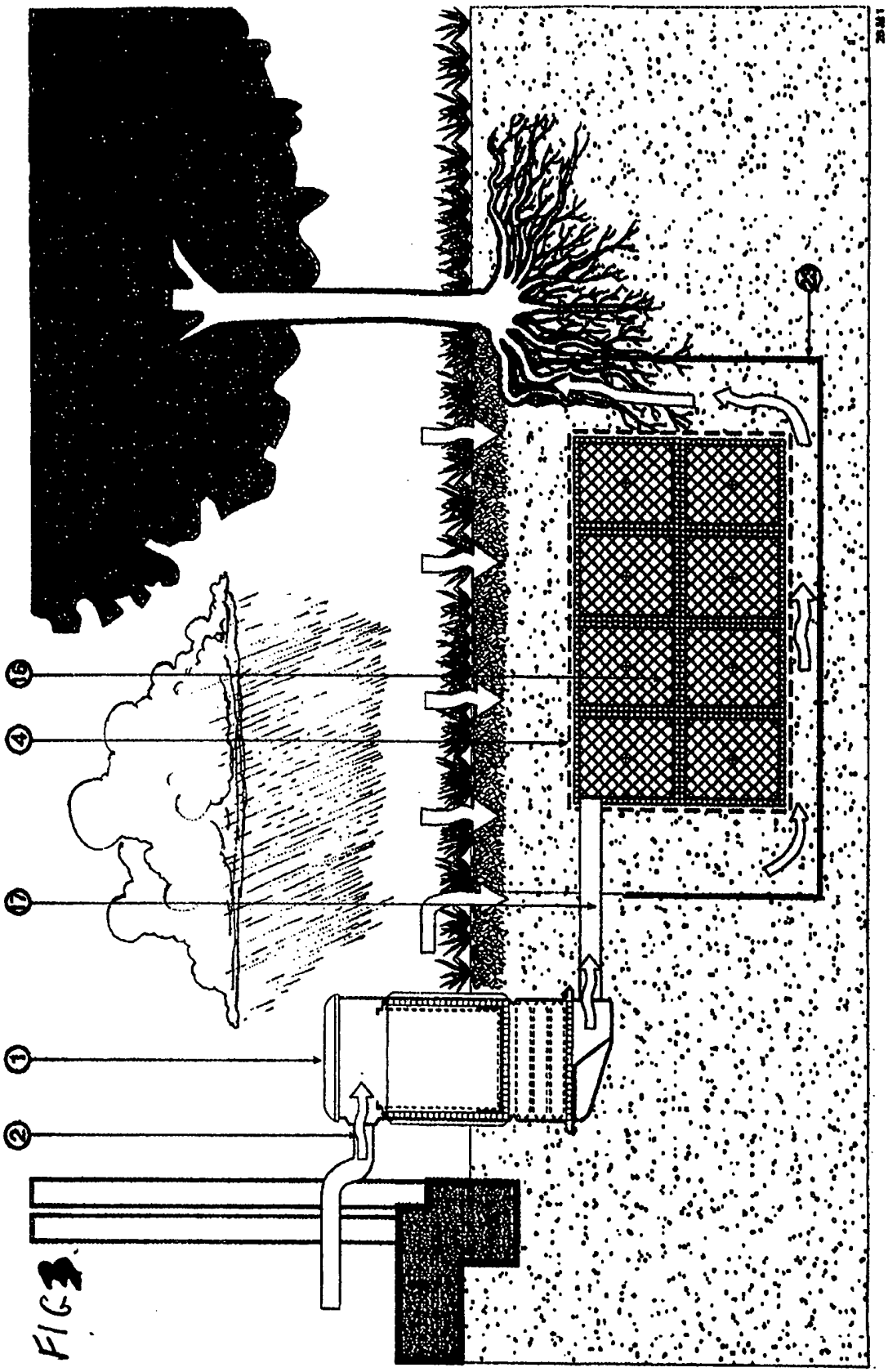


FIG 3.

Fig 4

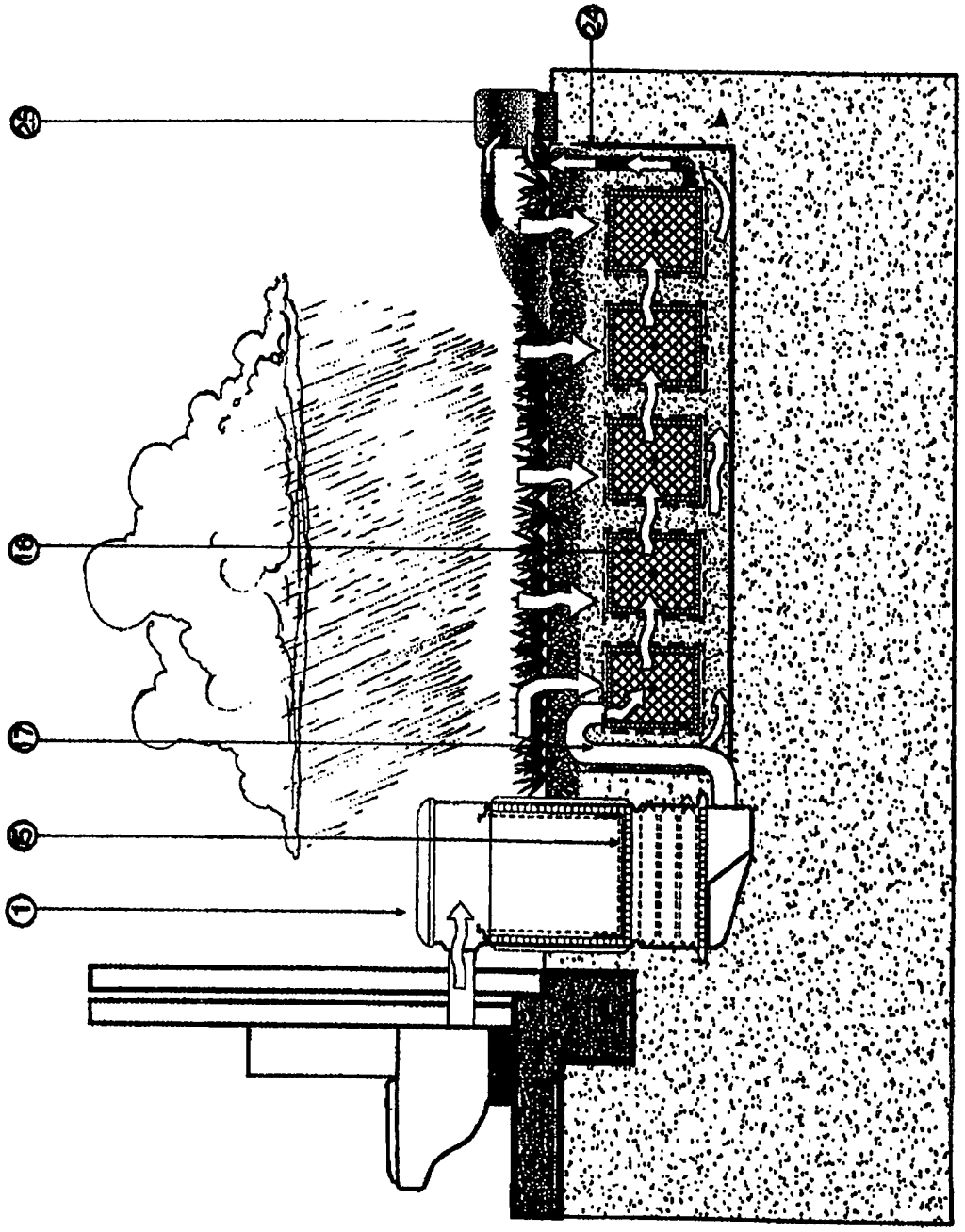


Fig 5

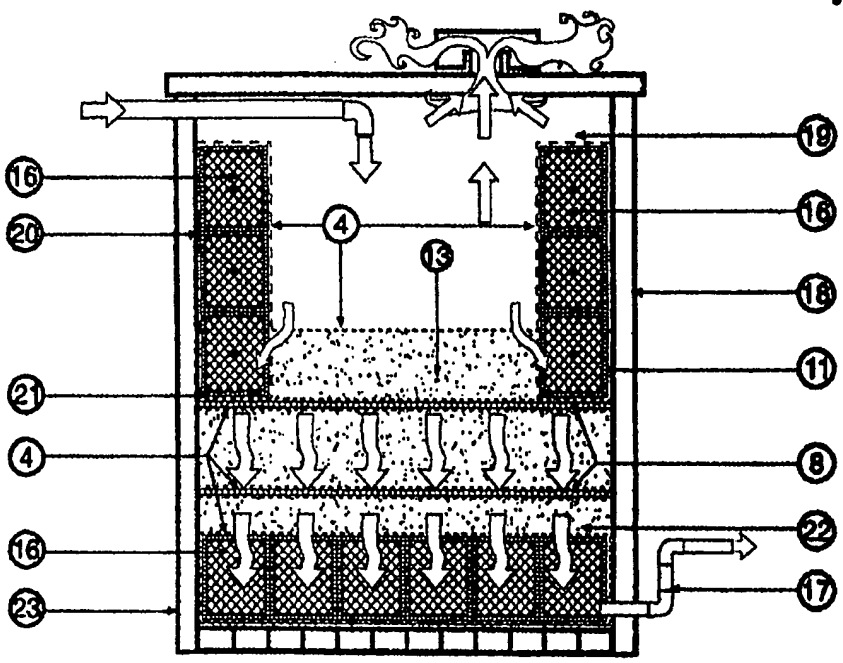


Fig 8

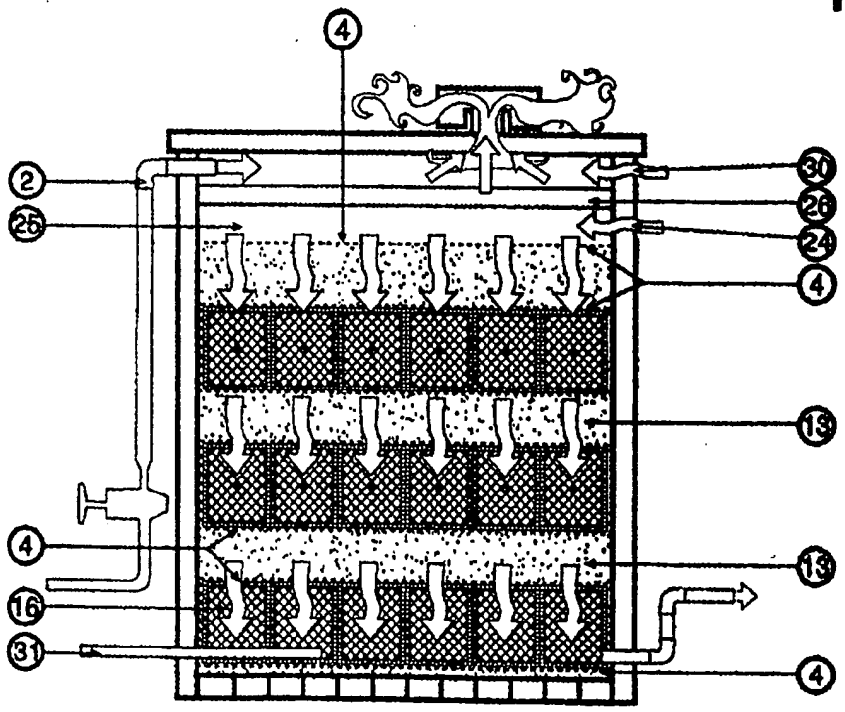


Fig 6

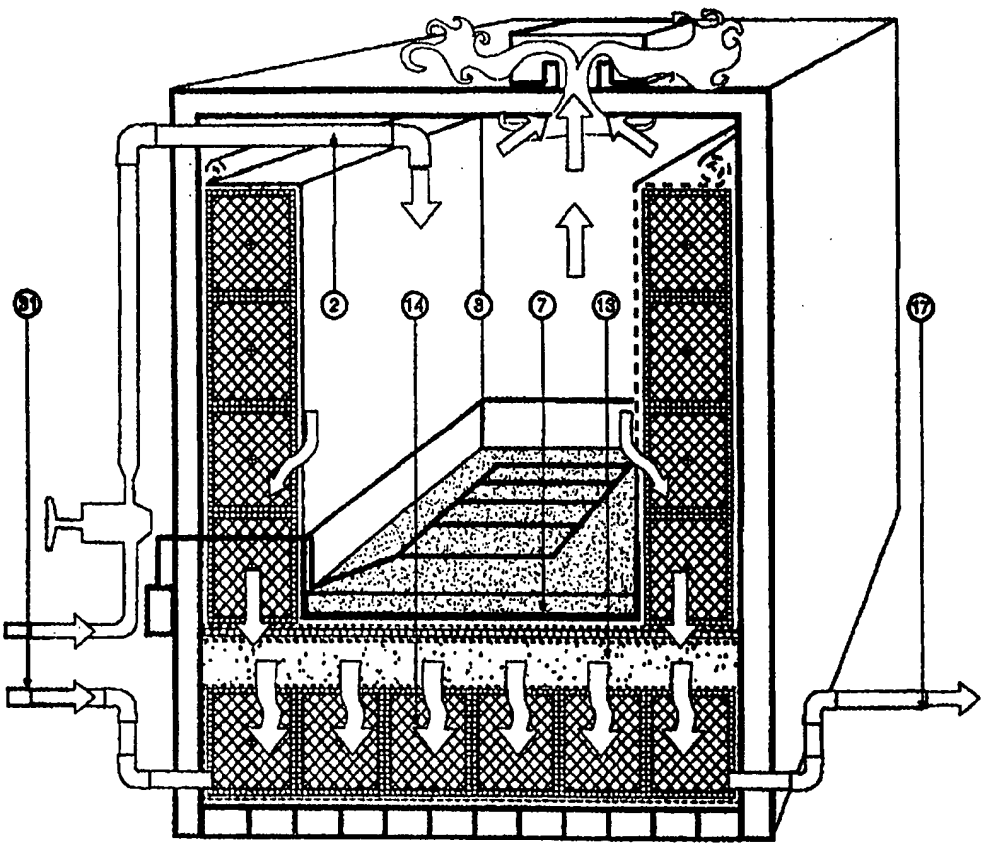


Fig 7

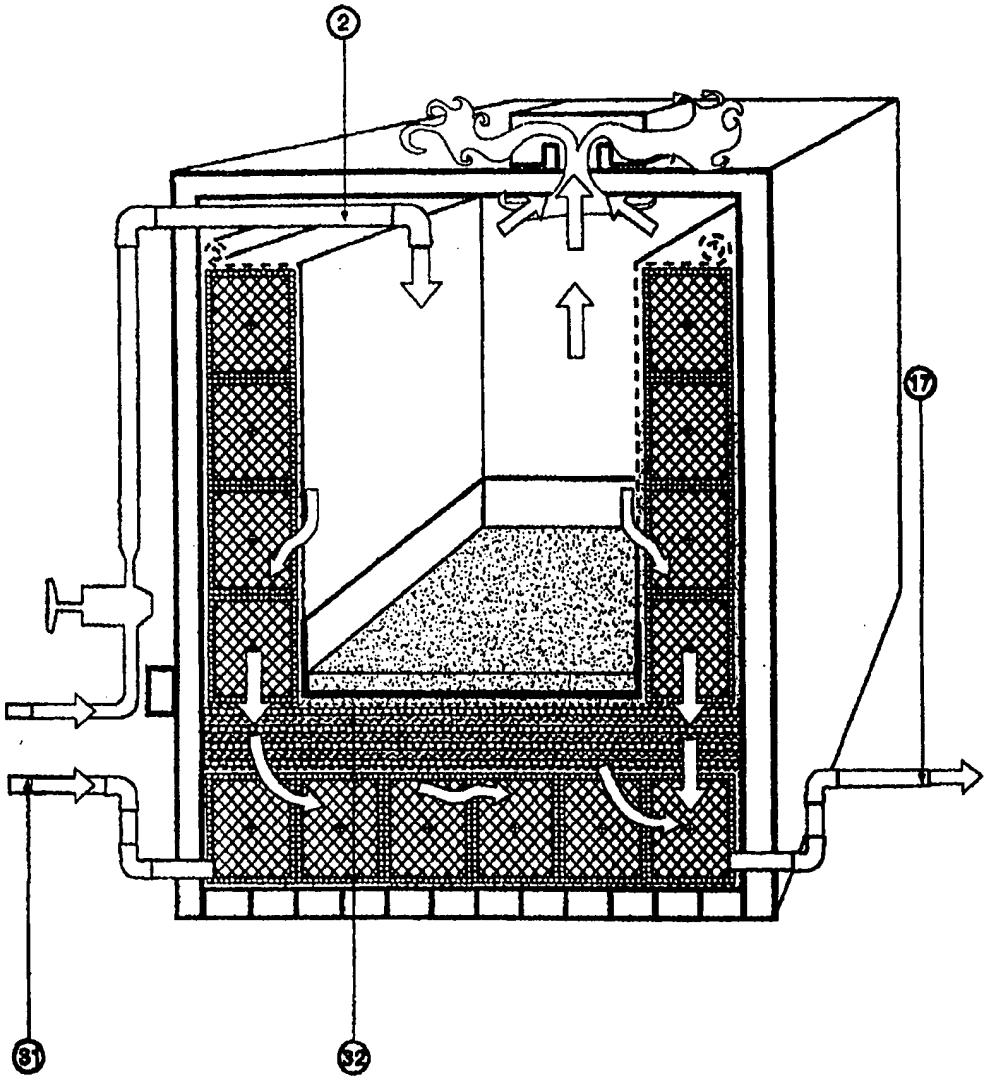


Fig 9

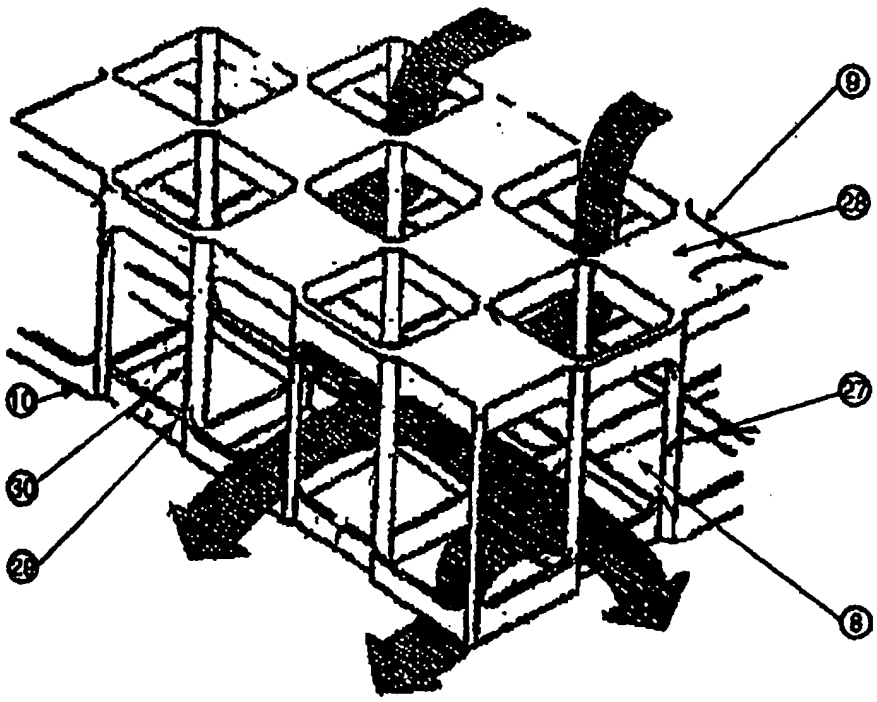
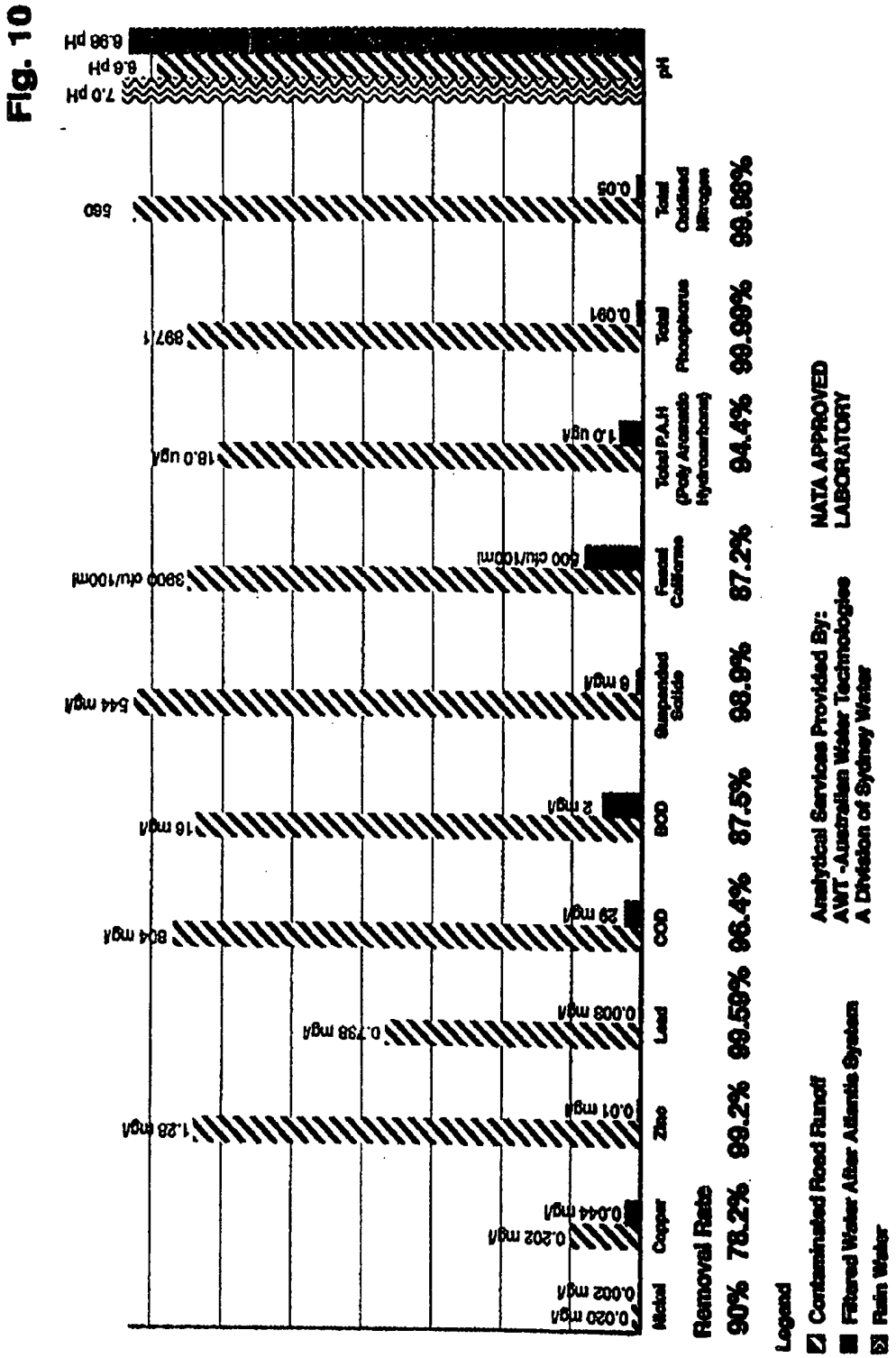


Fig. 10


Metal
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Zinc
Lead
COD
BOD
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Total Phosphorus
Total Oxidised Nitrogen
pH
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Filtered Water After Atlantis System
Rain Water
Analytical Services Provided By:
AWT -Australian Water Technologies
A Division of Sydney Water
NATA APPROVED
LABORATORY

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 98/00534

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: C02F 3/04, C02F 9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: C02F 3/04, 9/00, 3/02; C05F 3/06; C02C 1/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96/31437 A (DOWMUS PTY. LTD.) 10 October 1996 Pages 3-9, 12, example 1, claims 1,2,8,9,13, figures 1-4	1-7
X	Derwent Abstract Accession No. 96-382796/38, Class D 15, RU 2049737-C1 (TERENTEVA N.A.) 10 December 1995 Abstract	1-7
X	WO 96/33136 A (SCHLATTE) 24 October 1996 Figure 4	1-7

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

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Date of the actual completion of the international search
24 November 1998

Date of mailing of the international search report
- 1 DEC 1998

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 98/00534

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 3805615 A (MANNESMANN) 31 August 1989 Figure 1	1-7
X	EP 192631 A (STOISER & WOLSCHNER) 27 August 1986 Figures 1,2	1-7
X	Patent Abstracts of Japan, M-76, page 271 JP 51-115054 A (SHINKO KANKYO ENGINEERING K.K.) 10 September 1976 Abstract	1-7
X	DE 2755286 A (HOECHST AG) 13 June 1979 Figure 1	1-4
X	DD 233825 A (FORSCHUNGSZENTRUM WASSERTECHNIK) 12 March 1986 Whole document	1-4
X	US 3933641 A (HADDEN et al.) 20 January 1976 Column 3 line 40 to column 6 line 11, figures 2,3	1-4
X	EP 431993 A (VERSEAU DEVELOPPEMENT S.A. et al.) 12 June 1991 Columns 4, 7, 8, figures 1-4	1-4
X	Derwent Abstract Accession No. 96-169680/17, Class D 15, KR 9406405-B1 (PARK J.) 20 July 1994 Abstract	1,2
X	Derwent Abstract Accession No. 93-199929/25, Class D15, JP 05-123687 A (KURITA WATER IND LTD) 21 May 1993 Abstract	1,2
X	US 5240611 A (BURTON) 31 August 1993 Column 2 line 45 to column 3 line 26, column 4 lines 14-25, figure 1	1
X	DE 3911024 A (OMNITECH COMPUTERTECHNIK UND ELEKTROANLAGEN GmbH) 11 October 1990 Column 2 lines 30-32, figure 1	1